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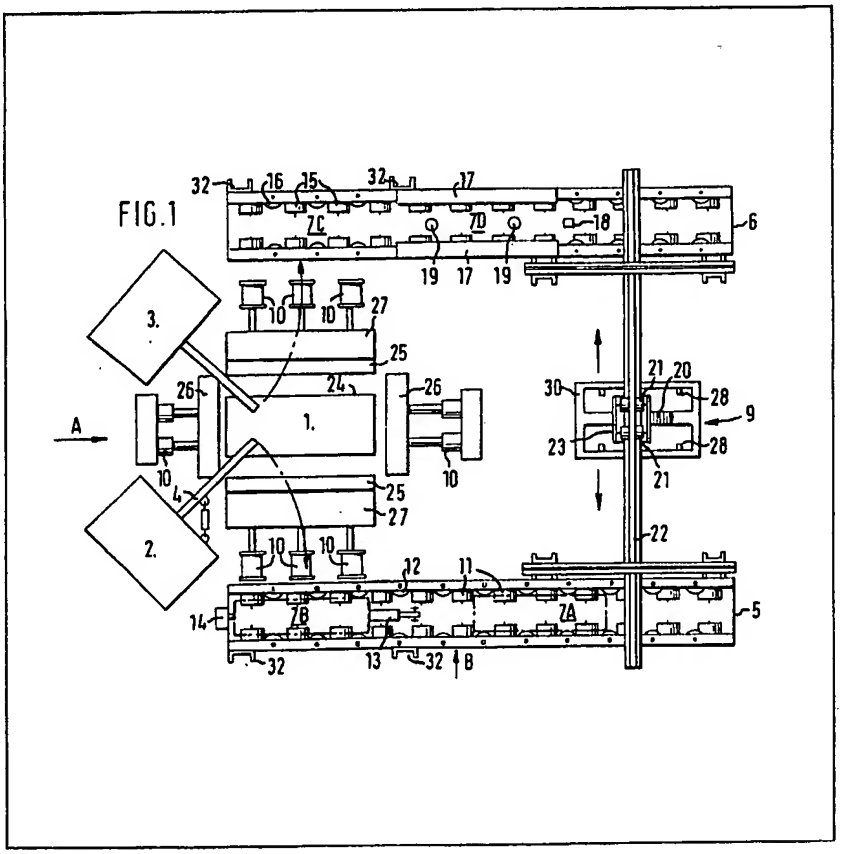
(54) **Conveying system in die-casting plant**

(57) In production of die-castings, particularly low pressure or gravity die-castings, moulding cores are assembled on a travelling pallet at a loading station (7A) on an input conveyor (5). The loaded pallet is then moved to a feed station (7B) from which it is transferred into a die assembly (1) as a further pallet and casting is removed therefrom and deposited at a removal station (7C) on an output conveyor (6). The die assembly then closes and molten metal is supplied thereto. While the casting in the die assembly is cooling, the pallet at the removal station (7C) is moved to an eject station (7D) where the casting and cores are separated, the pallet is cleaned and returned to the input conveyor (5) by an overhead crane (9) ready for re-loading and returning to the feed station (7A). The number of pallets used will depend on the cooling time of the casting but three is the preferred number. A suitable pallet is described.



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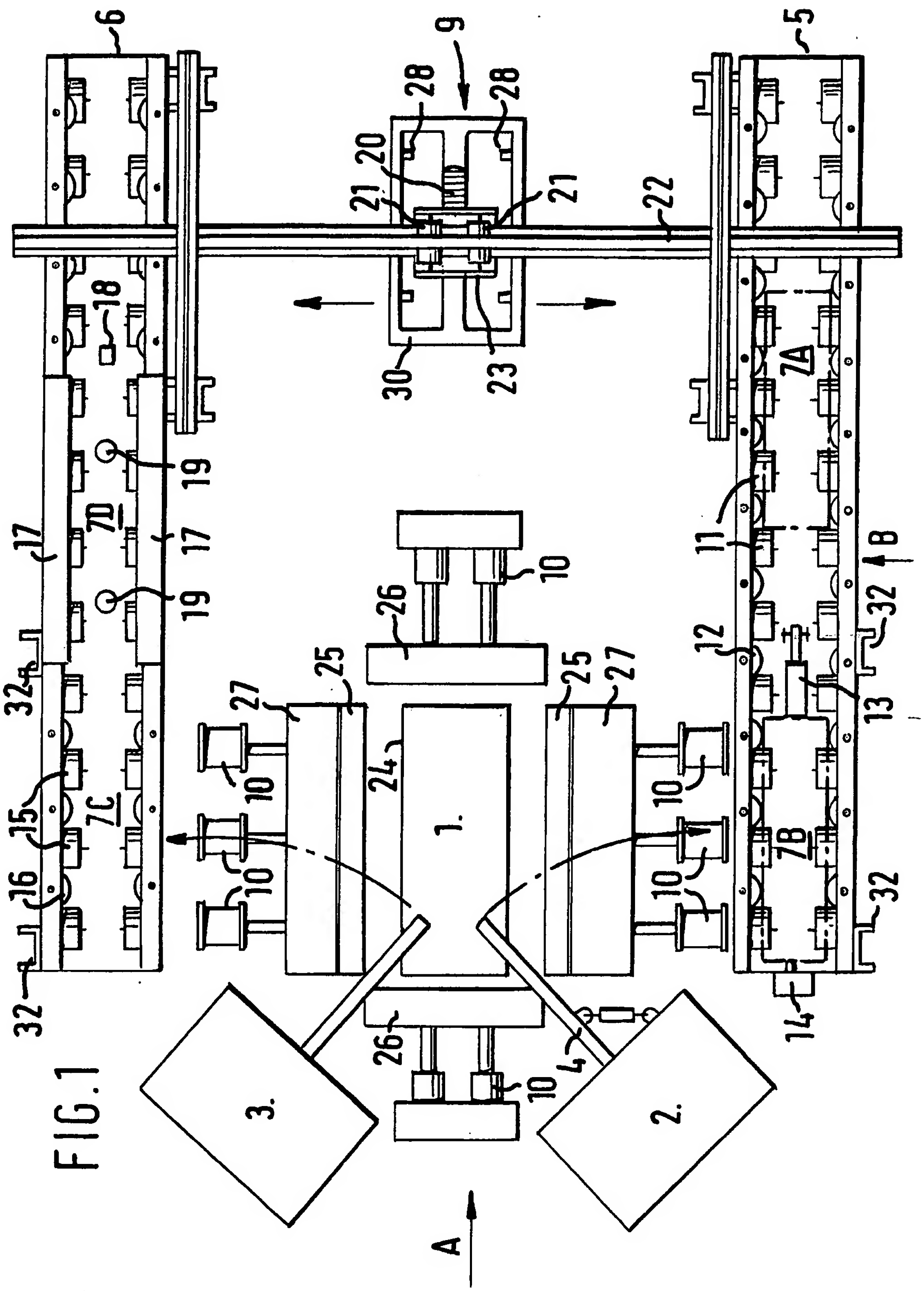

FIG. 1

FIG.2

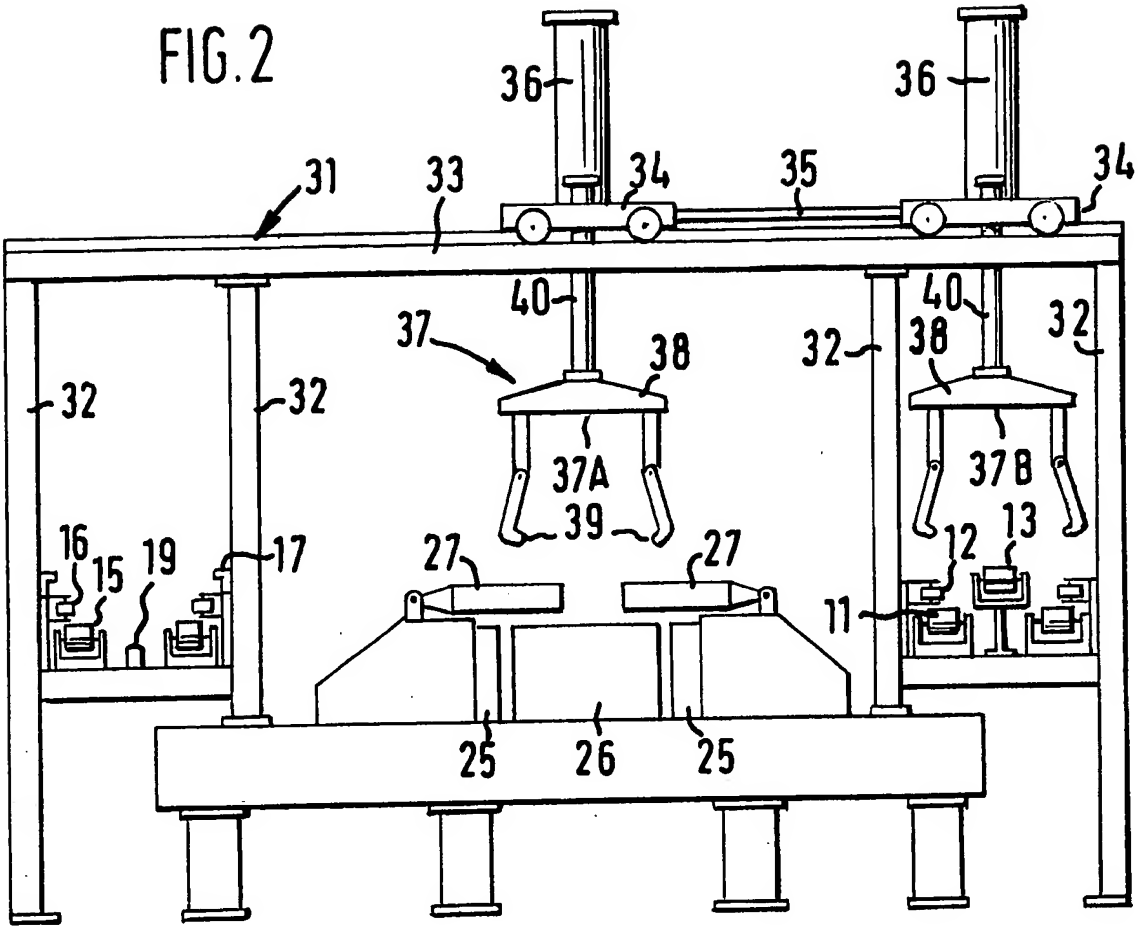
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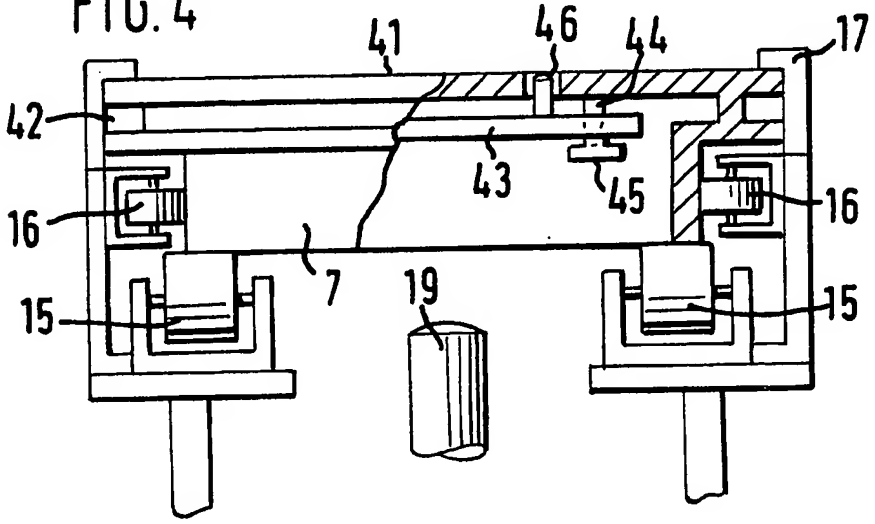
FIG.4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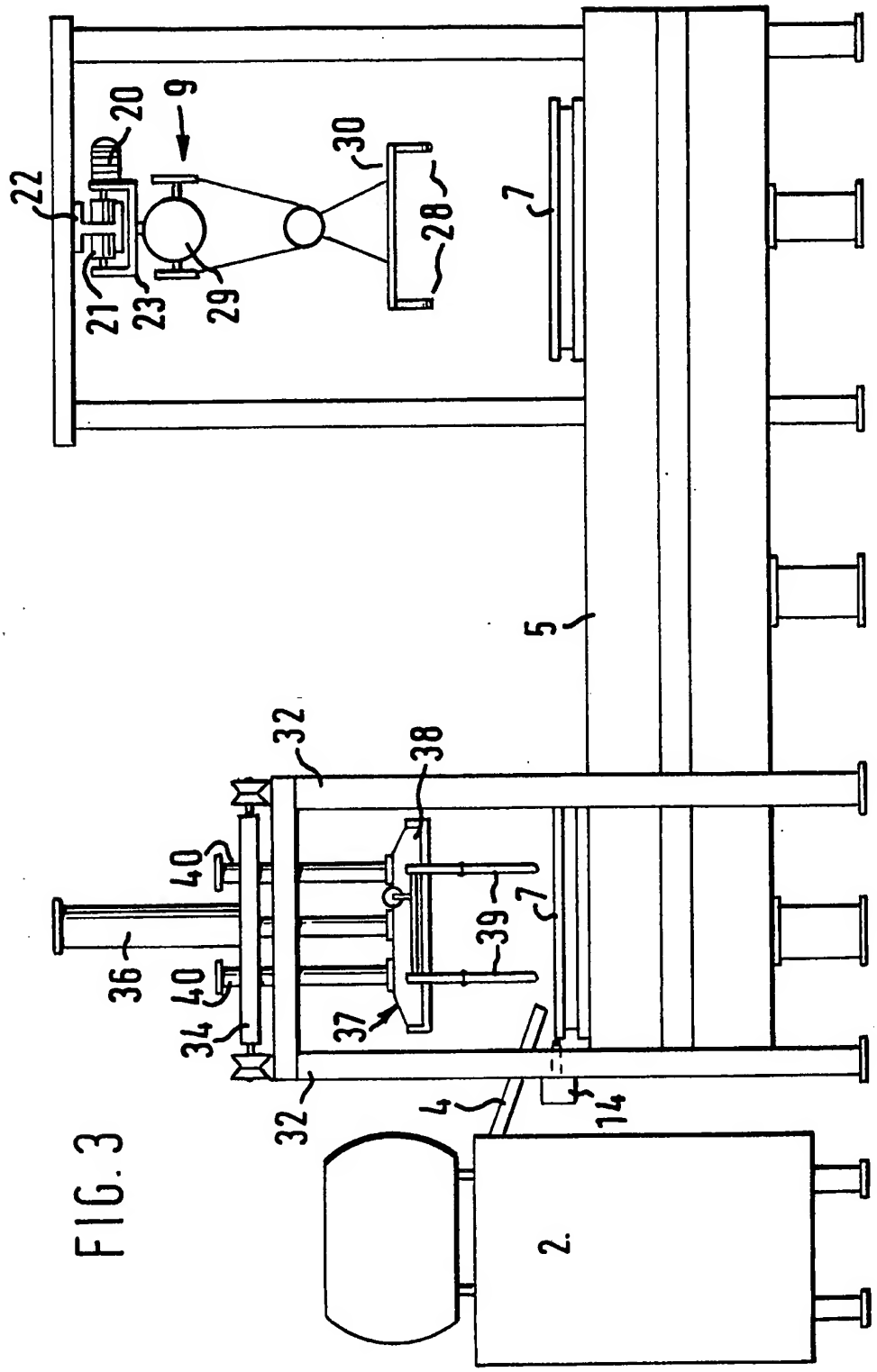

FIG. 3

SPECIFICATION

A method and apparatus for die-casting

This invention relates to a method and apparatus for die-casting and more particularly, but not exclusively, to a gravity or low pressure die-casting method and apparatus.

Die-castings are normally, produced by an operator manually loading a set of cores into a die which is then closed, filled with molten metal and left therein to cool until the casting has set. Depending on the casting being made, this cooling time period can be as little as one minute for a small casting or as much as ten minutes for a large casting such as a cylinder block. It will be appreciated that this cooling period dictates the throughput of the die.

It is therefore an object of the invention to provide a casting method which permits the operator to pre-prepare a set of cores ready for the next casting during the cooling period for the casting already in the die so that the former may be inserted in the die immediately the previous casting has been removed therefrom.

This object is achieved by arranging for the operator to pre-prepare a set of cores on a separate mobile pallet or cassette which, when inserted in the die, forms the bottom thereof. Thus, while the previous casting is cooling, the operator can be preparing the next set of cores on another pallet which may then be placed in the die once the previous casting and pallet are removed therefrom. By using a mobile pallet and an appropriate die assembly to accept it, it will be appreciated that the time period of the core loading step can be made to coincide with the cooling time of the casting so that utilisation of the die itself is increased and high productivity is achieved.

According to one aspect of the invention therefore there is provided a method of producing die-castings comprising the following steps:

a) positioning an already prepared set of cores on a pallet inside a die ready for casting,

b) closing the die and admitting molten metal thereto to produce the casting,

c) assembling a set of cores on another pallet upstream of the die and feeding said pallet to a feed station during the cooling time of the casting in the die,

d) opening the die when the cooling time for the casting therein has elapsed.

e) removing the casting and pallet therein and replacing it with the prepared pallet waiting at the feed station, and

f) repeating the cycle.

According to another aspect of the invention, there is provided an apparatus for producing die-castings comprising a die assembly, means for supplying metered quantities of molten metal to the die assembly, at least two travelling pallets, means for feeding one of said travelling pallets with a set of cores thereon to a feed station upstream of the die assembly and a pallet with a casting thereon from a removal station downstream of the die assembly, and means operable to transfer a pallet loaded with cores from the feed station into the die assembly and to remove from the die assembly the pallet with the casting thereon and transfer it to the removal station. Preferably, the removal of the pallet from the die and its replacement with the loaded pallet at the feed station are carried out simultaneously but they may be effected separately if desired.

The casting is removed from the die to a removal station, the feed station and the removal station preferably being spaced from the die by the same distance so that the pallet at the feed station and the pallet in the die may be respectively releasably engaged by spaced grippers on overhead handling means movable from a first position in which the pallet interconnected trolleys may be used.

In a preferred embodiment, separate pallets are fed to the feed station along an input conveyor whose direction of movement is generally at right angles to the direction of feed of the pallets to and from the die. Desirably, a pallet with a casting thereon is removed from the removal station along an output conveyor whose direction of movement is generally also at right angles to the direction of feed of the pallets through the die. Conveniently, after removal of the casting from the pallet, the empty pallet is taken from the output conveyor and transferred, by suitable means such as an overhead gripper arrangement, to the input conveyor where it receives another set of cores ready for feeding to the feed station. It will be appreciated, that instead of using the overhead gripper arrangement to transport the empty pallets between the input and output conveyors, a third conveyor could be used. Similarly, it is not essential to the invention that the input conveyor and output conveyor be arranged to operate at right angles to the direction of feed of the pallets through the die.

Preferably apparatus for carrying out the method of the invention is hydraulically powered although it can incorporate some pneumatic auxiliaries. It also preferably includes an electronic programable sequence control with inbuilt process timers. Manual core loading, ejection control and cleaning can be integrated into the automatic sequence of the apparatus and heating for the die and core carrying pallets is preferably provided as part of the machine.

Preferably the die is positioned centrally of the machine and includes two side pieces, two end pieces and twin top covers all hydraulically operated to close around the pallet with its core set thereon, the top covers having an arcuate movement so that they can initially clear the sides of the die but are then brought down onto them when in their final closed position.

Conveniently, two conveyors, for instance roller conveyors, are provided on each side of the die, the lefthand conveyor carrying pallets loaded with cores ready for placing into the die, the righthand conveyor carrying the completed castings on their respective pallets to an ejection and cleaning station.

Pallets on the input conveyor may come either direct from the cleaning and ejection station on the output conveyor or alternatively at the feed station and the pallet in the die are engaged thereby to a second position in which the pallet in the die is

removed therefrom and deposited at the removal station and the pallet which was at the feed station is deposited in the die.

Conveniently, the overhead handling means is a single trolley from which spaced sets of hooks extend to engage with the pallet at the feed station and the pallet in the die. Alternatively, a pair of separate from a buffer stored located between the output and input conveyors. Loading of the core sets onto a pallet is preferably done by hand, this operation being facilitated by a hand controlled but pneumatically powered lift pin system, the operator then preferably activating a hydraulic cylinder and drive roller system operably associated with the feed conveyor to move the pallet into its feed position at the feed station where it is retained by a catch ready for lifting and transfer to the die.

The removal conveyor preferably includes a propulsion cylinder which, propels a pallet deposited on the conveyor to a stop at which point it is located above a hydraulically driven but hand controlled ejector plate by means of which the operator separates the cores from the casting which may then be removed by an overhead hoist for subsequent processing. The pallet can then be cleaned and a movement stop released whereby the propulsion cylinder and a driven roller propel the pallet to the end of the conveyor for removal to a buffer store or to the input conveyor by means of a hand controlled electric hoist.

In order to maintain the temperature of the loaded pallet awaiting insertion into the die at the feed station and also of the main metal parts of the die, integral heating systems are preferably provided. These may be of any form such as a series of flame jets surrounding the base of the pallet and the die or electrical heaters may be used.

A preferred apparatus embodying the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a plan view of an apparatus of the invention but with the means for transporting the pallets to and from the die omitted, the die itself being schematically illustrated for ease of illustration;

Figure 2 is an end view of the apparatus of Figure 1 in the direction of arrow A but with the pressure delivery furnaces and the operating mechanism for the die assembly omitted for ease of illustration;

Figure 3 is a side view of the apparatus of Figure 1 in the direction of arrow B; and

Figure 4 is a cross sectional end view through one form of pallet in position at the eject station in Figure 1.

Referring to Figures 1 to 3 of the drawings, there is shown a gravity die-casting apparatus comprising a die assembly 1 fed by a pair of furnaces 2, 3 which supply thereto an adjustable metered delivery of molten metal on demand. The metal is arranged to flow from short movable launders 4 which swing into position for pouring but swing away to give clearance for die movements.

The control of the metered quantities of liquid metal and the timing and sequence of launder movement is achieved in known manner so no further description thereof will be given.

Arranged on either side of the central die assembly 1 are an input conveyor 5 and a take-off or output conveyor 6, these conveyors being parallel to each other and operable to transport cassettes or pallets 7 which carry thereon ready prepared sets of cores or finished castings respectively to and from the die assembly 1.

Finished castings are removed from a pallet on the output conveyor 6 at an eject station 70 and the empty pallet is then moved to the end of the conveyor and transferred back to the input conveyor 5 by means of an overhead crane 9.

The input conveyor 5 comprises a plurality of first rollers 11 rotatable about a horizontal axis and a plurality of second rollers 12 arranged above the rollers 11 and rotatable about a vertical axis. When a pallet 7 travels along said conveyor, it is supported on the rollers 11; its lateral edges engaging and being guided by the rollers 12 (see Figure 4).

A spring loaded catch 13 is provided on the input conveyor 5 and is operable to be depressed by a pallet 7 moving past it from loading station 7A but, once passed, it springs back up to prevent any backward movement of the pallet 7. A limit switch 14 is also provided at the end of the conveyor adjacent die assembly 1. As can be seen from Figure 1 the free end of the catch 13 is spaced from the limit switch 14 by a distance substantially equal to the length of a pallet 7 so that once a pallet has engaged the limit switch 14, it is locked in position 7B ready for feeding to the die assembly 1. This position will be referred to hereafter as the "feed station".

The output conveyor 6 is similar to the input conveyor 5 in that it comprises a plurality of first rollers 15 mounted for rotation about a horizontal axis and a plurality of second rollers 16 mounted for rotation about a vertical axis said second rollers being omitted in the region of the eject station 7D. In said region, the rollers 16 are replaced by a fixed overhanging lip 17 on each side of the conveyor arranged at a height such that a pallet 7 may slide beneath it. The pallet 7 is drawn from a removal station 7C by a transport cylinder (not shown) until a dead stop 18 is contacted by means of which the pallet is then locked in position at the eject station 70, said station being provided with a plurality of eject pins 19 movable from a lowered position which allows the pallet to be moved into position in the eject station to a raised eject position in which they engage with an ejection plate (to be described hereafter) on the pallet.

Once the cores and casting have been separated and the casting removed from the pallet, the pallet is blown clear, the ejector pins are lowered, the dead stop 18 is released whereupon the transport cylinder (not shown) continues its stroke to move the empty pallet towards the output end of the conveyor 6 ready to be transferred by the overhead crane 9 across to the input conveyor 5.

The overhead crane 9 is of conventional construction so it will not be described in any great detail but it comprises a motor 20 mounted on a carriage 23 with driving wheels 21, which rung along a rail 22. A further motor 29 is operable to raise and lower a

frame 30 provided with hooks 28 which releasably engage with the pallets 7.

Referring now to Figure 2, it can be seen that the die assembly 1 is located centrally between the input and output conveyors 5, 6 and comprises a base 24, two sides 25 two ends 26, and two top covers 27 all of which are hydraulically operable by means of pistons 10 (illustrated diagrammatically for ease of illustration) to close around a pallet with a set of cores thereon and define a mould for the object to be cast e.g. a cylinder block or head. The top covers 27 have an arcuate movement so that they initially clear the sides 25 but are then brought down on top of them when fully closed.

As already explained, the die assembly is fed with molten metal by the two furnaces 2, 3 each having a launder 4 which is pivotable so that it may be swung out of the way of the die assembly 1 to permit access thereto for the insertion and removal of pallets.

An overhead superstructure 31 (omitted from Figure 1 for ease of illustration) is arranged over the respective ends of the input and output conveyors 5, 6 and the die assembly 1. This superstructure comprises uprights 32 which support overhead rails 33 on which run overhead handling means, illustrated as a pair of wheeled trolleys 34 connected together by means of a bar 35. Each trolley is provided with a hydraulic cylinder 36 operable to raise and lower a gripper assembly 37 attached thereto which comprises a lifting plate 38 on which hooks 39 are pivotally mounted, said hooks being connected by appropriate hydraulic or mechanical linkages (not shown) to means operable to enable them to be engaged or disengaged from a pallet 7 waiting at the feed station or in the die assembly. A pair of guide pillars 40 are also secured to the lifting plate 38 and are slidably mounted in the trolley body 34.

As can be seen from Figure 2, the connecting bar 35 is of a length such that the trolleys 34 are spaced apart by a distance whereby each respective gripper assembly 37 is located directly above the feed station and the die assembly 1. The gripper assemblies are operable to be lowered to grip simultaneously a ready prepared pallet at the feed station and a pallet in the die to raise them and, on movement of the trolleys to the left as viewed in Figure 2, deposit the casting and pallet that was in the die on the output conveyor 6 at the removal station 7C and the ready prepared pallet that was at the feed station 7B into the die ready for casting.

A more detailed illustration of a pallet 7 can be found in Figure 4 which shows it in position at the eject station 7D prior to the eject pins 19 being raised. The pallet comprises a hollow body portion having an upper surface 41 to support the casting (now shown) and an annular recess 42 to receive the gripper hooks 39 of the gripper assemblies 37 or of the gripper hooks 28 of the overhead crane 9. Inside the pallet housing, an ejector plate 43 is guided for vertical movement on lugs 44 having abutments 45 to limit the downward movement. Ejector pins 46 are provided on the ejector plate 43, these being slidable in apertures in the upper support surface 41 to emerge therefrom to separate the cores from the casting when the eject pins 19 engage and lift the ejector plate 43. Any upward movement of the pallet as a result of this engagement is restricted by the lips 17. In order to maintain the temperature of the loaded pallet at the feed station 7B and the main metal parts of the die assembly 1 at the desired level, a series of flame jets (not shown) are provided. As these are of known type, no further description thereof will be given here.

An operating cycle of the illustrated apparatus is as follows:-

An empty pallet 7 is deposited on the input conveyor 5 by means of the overhead crane 9 and it is then moved to position 7A where an operator will place on it the necessary cores to produce the required casting, this operation being facilitated by a hand controlled pneumatically powered lift pin system (not shown) which lifts the main core to help the operator insert the subsidiary cores. When the cores have been loaded onto the pallet, the operator activates a hydraulic cylinder and driven roller system (not shown) to move the pallet into position 7B at the feed station, it being retained in this position by means of the catch 13, limit switch 14 having indicated that the pallet is in fact ready for transfer to the die assembly 1.

After the casting already in the die has cooled, the die automatically opens and the two gripper assemblies 37 are lowered from their position in Figure 2 by means of the pneumatic cylinders 36 so that the hooks of gripper 37B engage in the recess 43 of the pallet waiting at the feed station 7B and those of gripper 37A engage in the recess 43 of the pallet with the casting on it in the now open die assembly. Having engaged the pallets, the grippers 37A and 37B are raised clear of the open die assembly 1 and the trolleys 34 move to the left as viewed in Figure 2 until the casting and pallet held by gripper 37A is over the output conveyor 6 and the ready prepared pallet which was at the feed station 7B is over the open die assembly. The grippers 37A and 37B are then lowered by means of the cylinders 36 to deposit the pallets at their respective new locations and the trolleys 34 then move back to the right and return to their original position shown in Figure 2 ready for the next cycle. The die then closes. Launders 4 from the furnaces 2, 3 swing into position over the die and the required quantity of molten metal is fed thereto and the casting is again left in the die for the required cooling period.

Meanwhile, the pallet with the casting on it which is on the output conveyor 6 is moved by the propulsion cylinder (not shown) to the eject station 70 where it abuts the dead stop 18 when it is located above the ejector pins 19. The operator then activates the ejection movement, and the pins 19 rise up to engage the ejector plate 43 in the pallet and cause the ejector pins 46 thereon to emerge from the pallet upper surface 41 and separate the casting from its cores in known manner. Once this has been done, a movement stop (not shown) is released and the propulsion cylinder and a driven roller (also not shown) propel the pallet to the end of the conveyor 6 where it is cleaned and made ready to be transferred by the overhead crane 9 either to a buffer store

between the two conveyors or directly back onto the input conveyor 5 ready for loading with cores again.

Once on the conveyor 5, the operator again loads it with cores at 7A and feeds it to position 7B ready for the next cycle. By this time the cooling period for the casting in the die assembly 1 will have elapsed and the die will have opened automatically for the cycle to be repeated. Provided a loaded pallet is present at the feed station 7B, indicated by means of the limit switch 14, the cycle will re-commence. If a loaded pallet is not ready in position at 7B, then the apparatus automatically comes to a halt until it can be restarted manually when the operator is ready.

Preferably, the illustrated apparatus is operated using three pallets as this permits one pallet to be kept ready at the feed station, one in the die and a travelling one which can be cleaned and reloaded. If, however, the casting in the die has a particularly long cooling period, e.g. 10 minutes in the case of a cylinder block, it will be appreciated that only two pallets could be used as there would be sufficient time to recirculate and reload the pallet from the die by the time the next casting had cooled and the die reopened. More than three pallets, are used, extra heaters would have to be provided to keep the pallets warm in the pallet store prior to them being fed to the loading area on the input conveyor.

The illustrated apparatus may be used to produce castings in a variety of sizes but it is particularly suitable for producing large ones such as automobile cylinder blocks. Furthermore, the castings may be of any one of a number of suitable materials such as aluminium, magnesium or cast iron.

CLAIMS

1. A method of producing a die-casting comprising: positioning an already prepared set of cores on a travelling pallet inside a die assembly ready for casting, closing the die assembly around the pallet to define a moulding space therewith and admitting molten metal thereto to produce the casting, assembling a set of cores on another pallet upstream of the die and feeding said pallet to a feed station while the casting in the die is cooling, opening the die when the casting has cooled, removing the casting and pallet from the die to a removal station and replacing it with the prepared pallet from the feed station, and repeating the cycle.

2. A method as claimed in claim 1 wherein the pallet and casting thereon is removed from the die assembly and simultaneously replaced with the prepared pallet from the feed station.

3. A method as claimed in claim 1 or claim 2 wherein the pallets are initially lifted from the feed station and the die assembly prior to being transferred to respectively the die assembly and the removal station.

4. A method as claimed in any of claims 1 to 3 wherein the pallets are lowered into position in the die assembly and removal station.

5. A method as claimed in any of claims 1 to 4 wherein the pallets are fed to and from the feed and removal stations in a direction generally parallel to each other, the pallets being transferred laterally with respect to said directions to and from the die assembly.

6. A method as claimed in claim 5 wherein an empty pallet is returned from the output direction to the input direction by transferring it laterally therebetween.

7. Apparatus for producing die-castings comprising a die assembly, means for supplying metered quantities of molten metal to the die assembly, at least two travelling pallets, means for feeding one of said travelling pallets with a set of cores thereon to a feed station upstream of the die assembly and a pallet with a casting thereon from a removal station downstream of the die assembly, and means operable to transfer a pallet loaded with cores from the feed station into the die assembly and to remove from the die assembly the pallet with the casting thereon and transfer it to the removal station.

8. Apparatus as claimed in claim 7 wherein the pallet transfer means are arranged to simultaneously remove the pallet from the die assembly to the removal station while simultaneously replacing it with the pallet from the feed station.

9. Apparatus as claimed in claim 7 or claim 8 wherein the pallets are transferred between the feed station, die assembly and removal station by overhead handling means operable to be lowered to grip a pallet at said feed station and die assembly respectively and then raise said pallets and transfer them respectively to the die assembly and removal station where they are again lowered into position.

10. Apparatus as claimed in claim 9 wherein the overhead handling means comprises a pair of spaced trolleys movable between the feed and removal stations on overhead rails, each of said trolleys being provided with its own gripper assembly operable to releasably engage a pallet, said trolleys being rigidly connected to each other but spaced apart by a distance the same as that between the feed station, die assembly and removal station.

11. Apparatus as claimed in any of claims 7 to 10 wherein the die assembly comprises a pair of side walls, a pair of end walls and a pair of top covers, all of which are operable to close around a pallet to define a moulding space therewith.

12. Apparatus as claimed in any of claims 7 to 11 wherein pallets are fed to the feed station and from the removal station along respective input and output conveyors which are arranged parallel to each other and substantially at right angles to the direction of feed of the pallets to and from the die assembly.

13. Apparatus as claimed in claim 12 wherein a travelling crane is provided to transfer an empty pallet from the output conveyor to the input conveyor.

14. Apparatus as claimed in any of claims 7 to 13 wherein a locking catch is provided to retain a loaded pallet in position once it has arrived at the feed station.

15. Apparatus as claimed in any of claims 7 to 14 wherein a timer is operably connected to means for opening the die assembly so that the die is automatically opened when the cooling time for the casting therein has elapsed.

16. Apparatus as claimed in claim 15 wherein a switch is provided at the feed station which is operably connected to the means for transferring a pallet from the feed station to the die assembly whereby the transfer means will only engage the pallet to transfer it to the open die assembly provided a loaded pallet is present at the feed station.

17. Apparatus as claimed in any of claims 12 to 16 wherein an eject station is provided on the output conveyor, said station having ejector pins operable to be raised to cause the casting to be separated from the pallet.

18. A pallet for use with the method or apparatus of any of the preceding claims comprising a hollow body, an ejector plate slidably mounted for vertical movement within the body, the upper surface of said body having apertures therein from which ejector pins are arranged to emerge when the ejector plate is raised.

19. A pallet as claimed in claim 18 wherein the pallet is provided with a peripheral recess to receive hooks of transfer means engageable therewith.

20. A pallet substantially as herein described with reference to the accompanying drawings.

21. Apparatus substantially as herein described with reference to the accompanying drawings.

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